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ORIGINAL ARTICLE

A new test of action verb naming: normative data from 290 Italian adults

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Abstract

Introduction Verbs and nouns can be selectively impaired, suggesting that they are processed, at least in part, by distinct neural structures. While several tests of object naming are available, tasks involving action verb naming with normative data are lacking. We report the construction and standardization of a new test for the assessment of picture naming of actions.

Material and methods The test includes 50 stimuli, strictly controlled for several confounding variables. Normative data on 290 Italian subjects pooled across homogenous subgroups for age, sex, and education are reported.

Results Multiple regression analyses revealed that age and education significantly correlated with the subject's score. In particular, increasing age negatively affected performance, while the performance increased with a higher education.

Conclusions In the clinical practice, the availability of equivalent scores will help the comparison with performance in the picture naming of objects. This test allows investigating action naming deficits in aphasic patients, in Parkinson's disease patients and in further neurodegenerative disorders, in which a specific impairment of action verbs is expected, filling a gap in the clinical neuropsychological assessment.

Keywords Naming of actions · Neuropsychological assessment · Aphasia · Noun-verb dissociation · Parkinson's disease

Introduction

Verbs and nouns are word types that differ at many levels, namely, semantic, lexical, and grammatical level (see, e.g., [1] for a review). Indeed, verbs are considered less referential [2] and concrete than nouns and can take a number of different inflections. Moreover, verbs and nouns are processed by at least in part separate neural structures, as suggested by the fact that they can be selectively impaired, although which structures are involved in naming objects and verbs is still a matter of debate (see, e.g., [3], or [4], for reviews; [5] for a recent study).

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Neuropsychological data suggests that nouns require the activity of left temporal regions, while left posterior inferior frontal areas subserve verb processing [6, 7], a result replicated in neurodegenerative conditions (see below). While there is agreement concerning temporal lobe and noun processing, the role of the frontal areas in verb processing is more controversial, since some studies point to a possible critical role of parietal and temporal regions [5, 8, or a distributed network [4, 9, 10].

A deficit in lexical retrieval is a hallmark of all types of aphasia [11], and when evaluating picture naming, both nouns and verbs, which in experimental designs refer to actions, should be tested, because they can be differentially impaired in neurological patients. Indeed, aphasic patients can show a disproportionate deficit in action naming as compared to naming of objects [12–15]. Patients with non-fluent and semantic variants of primary progressive aphasia demonstrate similar pattern of dissociation between naming actions and naming objects [16] as vascular patients (for reviews see [1]): non-fluent progressive aphasics are more impaired with verbs than nouns, while the opposite pattern is seen in the semantic variant. Apart from this dissociation observed in aphasic patients, there are many additional pathological conditions in which a selective impairment of action verbs can be found. A selective

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impairment on oral confrontation naming of verbs was reported in a patient affected by progressive supranuclear paralysis (PSP) [17]. Early-stage Parkinson's disease (PD) patients show deficits in action naming ([18–22]; see23 for review). Finally, action naming seems to be impaired in patients with amyotrophic lateral sclerosis [24].

Despite the observation of a disproportionate impairment of verb production in several diseases, in clinical practice, action naming is not assessed as frequently as object naming. In fact, in Italian, as in many other languages, several standardized object naming tests are available [i.e., 25, 26], but this is not the case for verbs. This is peculiar, since in order to judge whether a subject is performing at a normal level on a given test, it is necessary to partial out the influence of factors such as old age and low education, which can lower the scores [27]. Also, we are in need for stimuli that are controlled for frequency of use, imageability, instrumentality, prototypicality, age of acquisition, and several other relevant variables, as it is usually the case for objects. In fact, there are database of action pictures, for example, in Russian [28], but no test has been constructed with this material. A battery for assessing object and action naming was developed in English [29] in response to the lack of materials for investigating the difference between the availability of nouns and verbs. This battery, the *Object and Action Naming Battery* (OANB), has proved to be a useful tool in clinical practice and has been adapted to several languages such as Spanish [30], French [31], Dutch [32], and Saudi Arabian [33]. The OANB is a comprehensive naming battery that consists of 162 black and white line drawings of objects and 100 of action. This battery has been used also to assess noun and verbs in Spanish/English bilingual adults [34]. Another available action naming task is included in the DuLIP (Dutch Linguistic Intraoperative Protocol, [35]), but this battery is designed for intraoperative language mapping. The DuLIP was tested on 250 healthy adult volunteers. Action naming consists of 60 stimuli, and retrieval of the verb in the third person singular is required, in order to test also syntactic processing. However, as far as we understand, there are no adjusted scores, although a significant effect of age and education was found.

Normative data for naming are of course specific for each language and population, as well as several relevant variables, such as frequency of use and age of acquisition. From this perspective, an interesting effort was recently carried out by Duñabeita et al. [36], who developed a set of 750 color drawings for both objects and actions, which they validated across 7 different languages. This is the only proper resource that might be applied cross-linguistically, as far as we are aware. However, the battery was only validated on adult, unimpaired speakers, which makes its suitability for brain-injured patient assessment and research unclear.

An action naming test for Italian was developed a few years ago by Crepaldi et al. [37], which was indeed specifically tailored toward aphasic patients. However, these authors did not validate their battery, across a span of unimpaired speakers of different ages and education levels—but the effects of these demographic variables are to be taken into account if one wants to use the test outside of the original research context, as a general-purpose assessment tool. Therefore, our aim was to collect normative data for this picture naming test of actions, selecting controlled stimuli on a population that included people from 20 to > 85 years, given the increase in the average length of life.

Materials and methods

Participants

Two hundred and ninety healthy Italian volunteers ($n = 290$) were included in the study, 142 males and 148 females. Mean age and mean education were 54.10 years (range 19–98, $SD =$ 19.2) and 12.26 years (range 3–23, $SD = 4.26$), respectively. Inclusion criteria were: (i) age ≥ 18 years, (ii) absence of neurological or psychiatric diseases, or of any potential medical diseases, in addition to no history of alcohol and/or drug abuse, and (iii) right handedness. Participants were selected in order to balance demographic variables (age, education, sex) that may affect performance (see Table 1). They were divided in seven groups according to age (19–29, 30–39, 40–49, 50–59, 60–69, 70–79, ≥ 80) and in five groups according to education (≤ 5, 6–8, 9–13, 14–16, ≥ 17). They were recruited from different sources: (i) relatives, friends, and colleagues of the authors and (ii) spouses, relatives, and caregivers of in- and outpatients of the hospital where two authors (BZ and AC) worked (Fondazione IRCCS Ca′ Granda – Ospedale Maggiore Policlinico, Milan, Italy and Istituto Clinico Humanitas). The ethnic background of all participants was Caucasian, and they were all native Italian speakers. At the time of testing, they were all living in Italy. They also received education in Italian. Participants did not receive any financial reimbursement or any other compensation. The study was approved by the local ethical committee of the University of Milano-Bicocca.

Material

A picture naming test of 50 actions was taken from Crepaldi et al. [37]. Items in that study were selected from an initial set of 123 line drawings and were included in the battery when there was a name agreement ≥ 85% (as obtained from an independent sample of participants in the original study).

The major lexical-semantic variables that affect lexical retrieval (namely, word frequency, imageability, age of acquisition, and word length) were collected. Oral word frequency

Table 1 Distribution of the study group according to age and education level. Values are number of subjects

Age, years	19–29	30–39	40–49	50–59	60–69	70–79	≥ 80	Total
Educational level								
≤ 5								
Men	0	0	0	3	5	5	5	18
Women	0	0	0	3	5	5	5	18
6–8								
Men	3	5	5	5	5	5	3	31
Women	2	5	7	6	5	5	5	35
9–13								
Men	6	5	5	5	5	5	5	36
Women	6	5	6	6	5	6	5	39
14–16								
Men	5	5	3	5	2	1	3	24
Women	5	6	5	5	2	2	0	25
≥ 17								
Men	7	5	6	5	3	5	2	33
Women	5	7	5	5	3	3	3	31
Total								
Men	21	20	19	23	20	21	18	142
Women	18	23	23	25	20	21	18	148

was computed as stem frequency, i.e., considering the total frequency of all inflected forms corresponding to a single citation form. Picture typicality was assessed by asking 23 healthy subjects, who did not take part in the normative data collection, to score each item using a seven-point scale according to how closely each drawing represented a prototypical exemplar of the action underlying the target verb. A rating of 1 indicated very low typicality while 7 corresponded to the highest typicality. Similarly, a seven-point scale was used to assess imageability: the same control subjects were asked to score each word according to the ease with which it evoked a mental image. Finally, a similar procedure was used to collect rating on age of acquisition: subjects were asked to score each word on a nine-point scale where 1 corresponded to acquisition within the second year of life, 2 within the third year of life, and so on until 9. A further group of 25 healthy undergraduate students (11 F and 14 M; age 24.5 ± 5.7 years) were asked to score each item using a 1–7 scale according to how much each verb does imply the production of non-automatized, complex movements (see [37] for rating scores).

Action naming test

Each participant was tested individually inside the Hospital, in a quiet room. Items were presented on a computer screen in PowerPoint format. Participants were asked to name 50 stimuli, namely, black-and-white drawings representing actions [37]. One point was assigned for each correct response (range 0–50). The first three items were examples. Verbs could be produced either in an infinitive (e.g., *camminare*, to walk) or finite form (e.g., *cammina*, he is walking) (see Table 2). Latencies longer than 3 s and self-repairs were scored as errors. The examiner said: “Now I show you pictures of actions, you should tell me the verb in infinitive or finite form. For example,…”. Responses given by 5% of the control subjects were accepted as an alternative correct answer.

Statistical analysis

Statistical analysis and scoring were performed according to the method described by Capitani et al. [38]. Multiple regression analyses were first performed to establish which demographic variables had to be included in the final model, which was based on significance testing on the individual predictors. We considered gender, age, and years of education, including their quadratic, logarithmic, and square root terms. For each variable, the first step was to identify the linear model through a covariance analysis, which proved to be the most effective in reducing residual variance.

Based on the relative influence of those variables that had a significant effect, correction grids were derived to adjust, when necessary, the performance of each newly tested participant for the effect of age, education, and gender. Adjusted scores were then used to compute tolerance limits. A subject's

Table 2 Stimuli for the action naming task with accepted alternative responses. In brackets the percentage of alternative responses

Action	Alternatives
Scrivere—to write—she is writing	
Bere—to drink—he is drinking	
Svegliarsi—to wake—he is waking up	
Cadere—to fall—he is falling	*Cascare* (1.7%)
Sbadigliare—to yawn—he is yawning	
Mordere/azzannare/morsicare—to bite—it is biting	*Spostare* (2.4%)
Spingere—to push—he is pushing	
Pattinare—to skate—she is skating	
Volare—to fly—it is flying	*Spedire* (2%)
Imbucare—to post—he is posting	
Arrestare/ammanettare—to arrest—he is arresting	
Salire—to climb—he is climbing	
Gonfiare/pompare—to pump—he is pumping	
Bussare—to knock—she is knocking	
Pregare—to pray—he is praying	
Baciare—to kiss—she is kissing	
Nuotare—to swim—to swimming	
Salutare—to greet—he is greeting	
Ruggire—to roar—he is roaring	
Fotografare—to photograph—she is photographing	*Scattare* (2.4%)
Pelare—to skin—he is skinning	*Sbucciare* (15.8%)
Decollare—to take off—it is taking off	
Sanguinare—to bleed—he is bleeding	
Soffiare—to blow—he is blowing	
Affondare—to sink—it is sinking	*Naufragare* (3%)/*Inabissarsi* (0.3%)
Raccogliere—to pick—she is picking	*Cogliere* (45%)
Crescere—to grow up—he is growing up	
Sciare—to ski—he is skiing	
Brillare/luccicare—it shine—it is shining	*Splendere* (4.5%)
Annaffiare—he water—he is watering	*Innaffiare* (0.3%)/*Bagnare* (3%)
Legare—to tie—he is tieing	*Slegare* (3.4%)
Affogare/annegare—to drown—he is drowning	
Versare—to pour—he is pouring	*Svuotare* (1.37%)/*Riempire* (4.4%)
Lanciare—to trow—he is trowing	*Tirare* (9%)
Scoppiare—to brust—it is brusting	*Esplodere* (3.4%)
Camminare—to walk—he is walking	*Passeggiare* (1.7%)
Dimagrire—to slim—she is slimming	
Piangere—to cry—she is crying	
Guidare—to drive—he is driving	
Atterrare—to land—it is landing	
Scuotere/scrollare—to shake—he is shaking	
Tagliare—to cut—she is cutting	
Sparare—to shoot—he is shooting	
Marciare—to march—they are marching	
Ridere—to laugh—he is laughing	
Starnutire—to sneeze—he is sneezing	
Fiorire—to blossom—it is blossoming	*Sbocciare* (3.4%)
Scivolare—to slip—he is slipping	
Fischiare—to whistle—he is whistling	
Scendere—to get off—he is getting off	
Leccare—to lick—it is licking	
Sollevare—to lift—he is lifting	*Alzare* (7.5%)
Accarezzare—to caress—she is caressing	

score is considered normal when it lies within the highest 95% of the population, whereas it is taken as pathological if it falls within the lowest 5%. Inferential cutoff scores were then derived for each gender, age, and education band, based on this approach. More generally, adjusted scores were transformed into a 5-point interval scale, from 0 to 4 equivalent scores, following a method used for other neuropsychological tests [38]. Zero corresponds to a score below the 5% tolerance limit and is therefore deemed pathological. The scores 1, 2, and 3 are intermediate and cover from the 5° to 20° percentile, from the 20° to 35° percentile, and from the 35° to 50° percentile in the population, respectively. A score of 4 corresponds to a performance fully within the normal range and flags a higher score than the population median. Equivalent scores simply combine nonparametric tolerance limits and the relevant demographic adjustment [38].

Results

The mean and median adjusted scores are reported in Table 3, together with the values delimiting the different equivalent scores. As described above, a multiple regression analysis with age, gender, and education as independent variables was performed. Overall, the model significantly captured variance in the scores [F (3,287) = 48.017, $p < 0.0001$]. Age and education significantly affected the participants' performance ($t = -2.49$, $p = 0.013$; $t = 2.725$, $p < 0.01$ respectively), while gender did not ($t = -1.47$, n.s.).

The linear model that proved to be the most effective in reducing the residual variance for the action naming was $y =$ raw score $- [-0.068 \times (\text{age} - 54.1)] - [0.305 \times (\text{education}$ $2.2586)]$.

Correction grids are reported in Table 4 (See Appendix for an example of how to use correction grids).

Table 3 Mean and median scores and cutoff value

	Mean (SD)	Median	Cutoff	Equivalent scores
Action naming test	44.87 (3.77)	45	≤ 36.86	0
			From 36.87 to 40.98	1
			From 40.99 to 43.42	2
			From 43.43 to 45.75	3
			≥ 45.76	4

Discussion

We collected normative data for action naming in order to provide a tool for the testing of Italian speakers, and particularly, brain injured patients. We considered a wide age interval, spanning from 19 over 80 years, due to the increased population mean age. A significant effect of age and education was found as in previous standardizations of language tasks on the Italian population [39, 40]. We observed, in particular, that performance decreased with aging, as it occurs in the majority of neuropsychological tests (with the interesting exception of naming by description [39]). Education, on the contrary, improved performance. Sex had no effect on it, instead.

Naming tasks are among the most widely used tests in neuropsychology, but till now, in Italy, there were no standardized tests with norms for action naming. The present test will be particularly useful also in patients with PD, to detect minimal language impairment that should appear especially in lexical retrieval of action naming. Moreover, this task has been included in a battery to assess language patients with low-grade gliomas [41], because standardized language batteries are not sensitive enough in these patients. According to Rofes and Miceli [42], verb tasks are preferable to object naming tasks in the case of frontal tumors, as lesion and neuroimaging data demonstrate that these regions play a critical role in verb processing. Accordingly, Akinina et al. [43] showed involvement of frontal regions, using VLSM, in 40 left hemisphere stroke patients, but did not find significant results in temporal or parietal areas. However, this observation is not entirely consistent. As reported in the introduction, while the role of the temporal lobe is well-established in noun processing, different neural correlates have been suggested for verb (action) processing, with different anatomical correlates related to different interpretations, at the semantic, lexical, or syntactic-morphological level (see [5] for a discussion). In contrast to studies reporting a frontal involvement, VLSM data collected on 102 patients who underwent surgery for a left frontal or temporal glioma showed that action verb scores correlated with the left parieto-temporal region, but not with frontal areas [5]. A similar result was obtained with vascular patients by Aggujaro et al. [8]. A third alternative is the involvement of several cortical areas in the frontal, temporal, and parietal lobes: Hauck and colleagues [44] compared language activation sites on 19 healthy participants with fMRI and repetitive navigated transcranial magnetic stimulation (rTMS). Verb generation and action naming during fMRI activated the supramarginal gyrus (SMG) and the fusiform gyrus, whereas rTMS evoked a considerable number of errors in the middle temporal and superior temporal gyri, in temporal areas, and in the middle frontal gyrus, in the prefrontal cortex. Similarly, Kemmerer et al. [9] found that the inferior frontal gyrus was involved in action verb processing, as well as the SMG and temporal areas. Overall, the evidence from the literature is still discordant and inconclusive. One possibility for this inconsistency could be that items are not always controlled for the same variables. For example, in the present study, many variables were considered, but not transitivity. Furthermore, action pictures necessarily include the representation of objects and agents involved in the action (e.g., the pictorial representation of the verb "to drink" requires the

Table 4 Correction grid for action naming test

	Age years													
Education, years	≤ 25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75	76–80	81–85	≥ 86
≤ 5	0.1	0.4	0.7	1.1	1.5	1.8	2.1	2.5	2.8	3.2	3.5	3.9	4.1	4.4
6–8	− 1	− 0.5	− 0.1	0.2	0.5	0.8	1.1	1.6	2.4	2.2	2.6	2.9	3.3	3.5
9–13	− 2.4	− 2	− 1.6	− 1.3	− 1	− 0.7	− 0.4	0.1	0.4	0.7	1.1	1.5	1.7	2.1
14–16	− 3.3	− 3	− 2.5	− 2.2	− 2	− 1.5	− 1.2	− 0.9	− 0.6	− 0.1	0.1	0.6	0.9	1.3
≥ 17	− 3.4	− 3.3	− 2.9	− 2.6	− 2.2	− 1.9	− 1.5	− 1.2	− 0.8	− 0.5	− 0.1	0.2	0.5	1.5

image of an agent and an instrument and an intransitive action like "to run" must include the agent); to date, there is no evidence against the possibility that objects and agents are implicitly processed, thus activating the neural circuits associated with object naming [10].

Further investigation with appropriate tests is required. We hope that our new tool will be of help both in clinic and research neuropsychology.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The study was approved by the local committee of the University of Milano-Bicocca

Appendix

To explain how to use the correction grid, we report an example of patient XZ, female, 60 years, 17 years of education, affected by non-fluent primary progressive aphasia. Her raw score was 44. Given her age and education, the raw score can be adjusted by subtracting 1.2 to the 44. The adjusted score is therefore 42.8, corresponding to an equivalent score of 2, which is a normal performance.

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